Dialysis	Membrane	with Im	proved	Removal	of	Middle	Molecule	? \$
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Claims

1. A hydrophilic, water-wettable, semipermeable hollow-fibre membrane for blood purification comprising a synthetic first polymer, the hollow-fibre membrane possessing an open-pored integrally asymmetric structure across its wall, a porous separating layer of thickness between 0.1 and 2 μm on its inner surface facing the lumen, and an open-pored supporting layer adjoining the separating layer, and having an ultrafiltration rate in albumin solution in the range of 5 to 25 ml/(h·m²·mmHg), characterised in that the hollow-fibre membrane, in the absence of additives stabilising the pores in the membrane wall and after prior drying, has a maximum sieving coefficient for albumin of 0.005 combined with a sieving coefficient for cytochrome c that satisfies the relation

$$SC_{CC} \geq 5 \cdot 10^{\text{-}5} \cdot \text{UFR}_{Alb}{}^{3} - 0.004 \cdot \text{UFR}_{Alb}{}^{2} + 0.1081 \cdot \text{UFR}_{Alb} - 0.25$$

2. Hollow-fibre membrane according to Claim 1, characterised in that it has a sieving coefficient for cytochrome c that satisfies the relation

$$SC_{CC} \ge 5 \cdot 10^{-5} \cdot UFR_{Alb}^3 - 0.004 \cdot UFR_{Alb}^2 + 0.1081 \cdot UFR_{Alb} - 0.12$$

- 3. Hollow-fibre membrane according to one or both of Claims 1 and 2, characterised in that it also comprises a hydrophilic second polymer.
- 4. Hollow-fibre membrane according to one or both of Claims 1 and 2, characterised in that the synthetic first polymer is a hydrophobic first polymer and the hollow-fibre membrane also comprises a hydrophilic second polymer.
- 5. Hollow-fibre membrane according to Claim 4, characterised in that the hydrophobic first polymer is an aromatic sulfone polymer such as polysulfone, polyethersulfone, polyphenylenesulfone or polyarylethersulfone, a polycarbonate, polyimide, polyetherimide, polyetherketone, polyphenylene sulfide or a copolymer or mixture of these polymers.
- 6. Hollow-fibre membrane according to Claim 5, characterised in that the hydrophobic first polymer is a polysulfone or a polyethersulfone.
- 7. Hollow-fibre membrane according to one or more of Claims 3 to 6, characterised in that the hydrophilic second polymer is polyvinylpyrrolidone, polyethylene glycol, polyvinyl alcohol, polyglycol monoester, polysorbate, carboxymethylcellulose, or a copolymer of these polymers.
- 8. Hollow-fibre membrane according to one or more of Claims 1 to 7, characterised in that the supporting layer extends from the separating layer across essentially the entire wall of the hollow-fibre membrane and has a sponge-like structure that is free from finger pores.
- 9. Hollow-fibre membrane according to one or more of Claims 1 to 8, characterised in that it has a maximum sieving coefficient for albumin of 0.003.

- 10. Hollow-fibre membrane according to one or more of Claims 1 to 9, characterised in that a polyelectrolyte with negative fixed charges is physically bound in the separating layer.
- 11. Hollow-fibre membrane according to one or more of Claims 1 to 10 with an ultrafiltration rate in albumin solution in the range of 10 to 25 ml/(h·m²·mmHg).
- 12. Method for producing a hydrophilic, water-wettable, semipermeable hollow-fibre membrane, comprising the following steps:
 - a. preparing a homogeneous spinning solution comprising 12 to 30 wt.% of a synthetic first polymer and, if necessary, other additives in a solvent system,
 - b. extruding the spinning solution through the annular slit of a hollow-fibre die to give a hollow fibre,
 - extruding an interior filler through the central opening of the hollow-fibre die, the interior filler being a coagulation medium for the synthetic first polymer and comprising a solvent and a non-solvent for the synthetic first polymer,
 - d. bringing the interior filler into contact with the inner surface of the hollow fibre to initiate coagulation in the interior of the hollow fibre and for formation of a separating layer on the inner surface of the hollow fibre and formation of the membrane structure,
 - e. passing the hollow fibre through a coagulation bath to complete the formation of the membrane structure if necessary and to fix the membrane structure,
 - f. extracting the hollow-fibre membrane thus formed, to remove the solvent system and soluble substances, and

- g. drying the hollow-fibre membrane, characterised in that the interior filler contains a polyelectrolyte with negative fixed charges, wherein the steps of the method are to be carried out in such a way that a hollow-fibre membrane according to Claim 1 is obtained with an ultrafiltration rate in albumin solution in the range of 5 to 25 ml/(h·m²·mmHg) and a maximum sieving coefficient for albumin of 0.005 combined with a sieving coefficient for cytochrome c that satisfies the following relation: $SC_{CC} \ge 5 \cdot 10^{-5} \cdot UFR_{Alb}^3 0.004 \cdot UFR_{Alb}^2 + 0.1081 \cdot UFR_{Alb} 0.25$
- 13. Method according to Claim 12, characterised in that the spinning solution also comprises 0.1 to 30 wt.% of a hydrophilic second polymer.
- 14. Method according to Claim 12, characterised in that the synthetic first polymer is a hydrophobic first polymer and the spinning solution also comprises 0.1 to 30 wt.% of a hydrophilic second polymer.
- 15. Method according to Claim 14, characterised in that an aromatic sulfone polymer such as polysulfone, polyethersulfone, polyphenylenesulfone or polyarylethersulfone, a polycarbonate, polyimide, polyetherimide, polyetherketone, polyphenylene sulfide, or a copolymer or mixture of these polymers is used as the hydrophobic first polymer.
- 16. Method according to one or more of Claims 13 to 15, characterised in that polyvinylpyrrolidone, polyethylene glycol, polyvinyl alcohol, polyglycol monoester, polysorbate, carboxymethylcellulose, or a copolymer of these polymers is used as the hydrophilic second polymer.

- 17. Method according to one or more of Claims 12 to 16, characterised in that the solvent system comprises a polar aprotic solvent.
- 18. Method according to one or more of Claims 12 to 17, characterised in that the polyelectrolyte is selected from the group of polyphosphoric acids, polysulfonic acids, or polycarboxylic acids.
- 19. Method according to Claim 18, characterised in that the polycarboxylic acids are homo- or copolymers of acrylic acid.
- 20. Method according to one or more of Claims 12 to 19, characterised in that the proportion by weight of the polyelectrolyte is 0.01 to 1 wt.% relative to the weight of the interior filler.